Joint Warfare System (JWARS) C4ISR Functionality

Presented to the Technical Interchange Meeting by
CDR Boots Barnes, JWARS Office
Deputy Director

Web Site:
https://www.jointmodels.mil/jwars/

Agenda

- Background
- C4ISR Overview
- C2 Implementation
  - JTF
  - Air Component
  - Land Component
  - Maritime Component
  - Logistics
  - TBM
- Summary

History

Calendar Year

1995	1996	1997	1998	1999

JWARS Operational Requirements Document (ORD) was approved by Joint Requirements Oversight Council (JROC).

DepSecDef designated Joint Data Support (JDS) as primary data support agency for JAMIP.

Deputy Secretary of Defense (DepSecDef) initiated Joint Warfare System (JWARS) development as one component of Joint Analytic Model Improvement Program (JAMIP).

Prototype Development

Production Development

Near Term Schedule

- **Release 1.3**
  - *Developer Testing completed in April 2001*
  - *Training and Installation began in May 2001*
  - *Distribution to requesting Beta Test sites for familiarization*
- **Release 1.4**
  - *Will include warfare functionality of Limited IOC*
  - *Completion date: April 2002*
  - *Distribution to Beta Test sites for Beta Testing*
- **Release 1.5**
  - *Will include changes resulting from Beta Testing*
  - *Estimated date: Early 2003*

Mission

Mission: Develop a state-of-the-art, constructive simulation that will:

- ***Provide a multi-sided and balanced representation of joint theater warfare***
- ***Be able to assess current and future operational concepts to include Joint Vision 2010's:***

  Dominant Maneuver, Precision Engagement, Focused Logistics, and Full-Dimension Protection
- ***Use C4 and ISR as the foundation for how entities perceive and interact with one another***

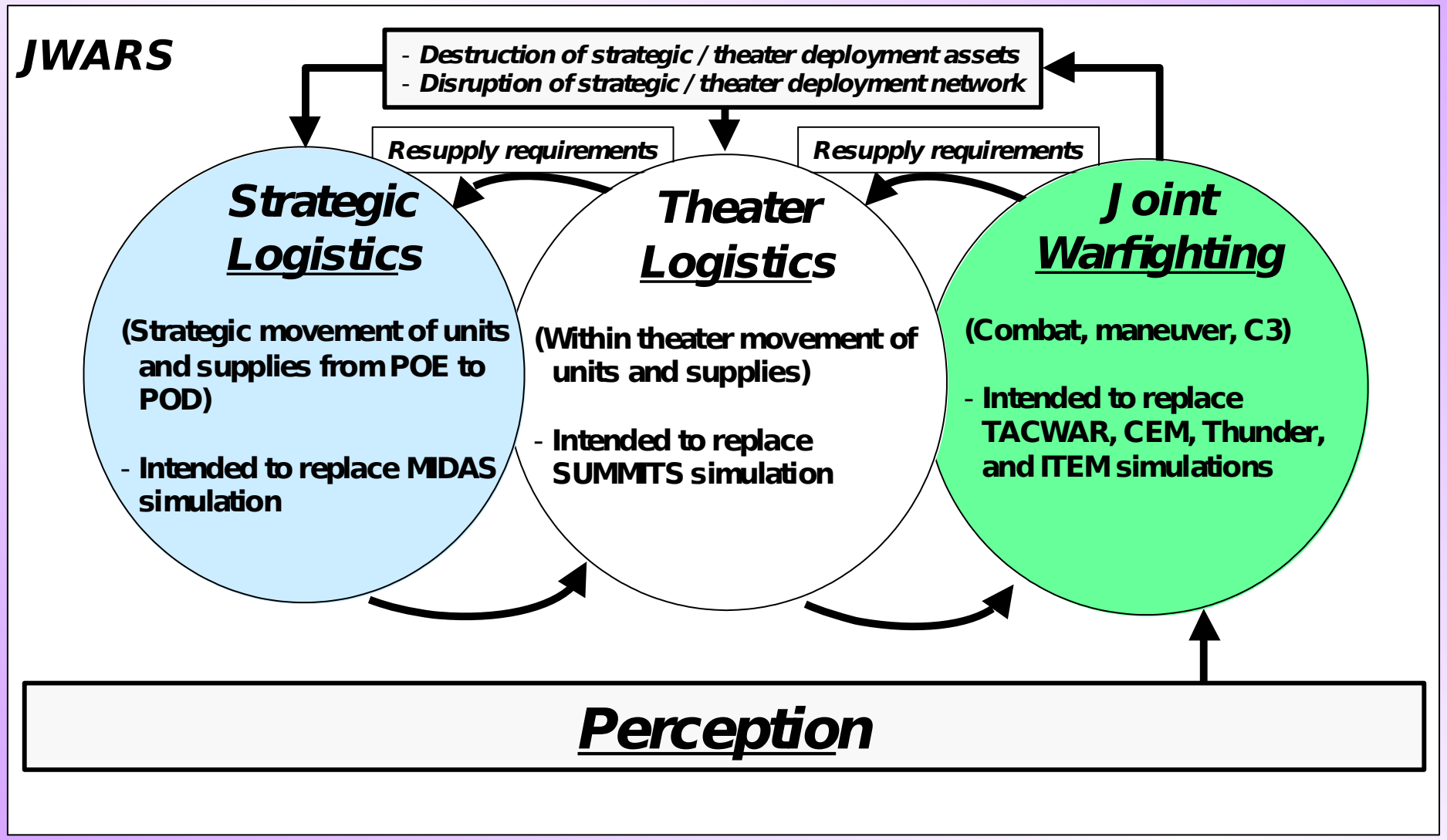
Users

- **Joint Staff**
- **Services**
- **CINCs**
- **OSD**
- **Joint Task Forces**
- **Other DoD org's**

Applications

1. **Force assessment**
2. **Planning and execution**
   - ***Deliberate planning***
   - ***Crisis action planning***
3. **System effectiveness and trade off analysis**
4. **Concept and doctrine development and assessment**

Requirements - Warfare Functionality (slide 2 of 2)


JWARS
- Destruction of strategic / theater deployment assets
- Disruption of strategic / theater deployment network
Resupply requirements
Resupply requirements
Strategic Logistics
(Strategic movement of units and supplies from POE to POD)
- Intended to replace MIDAS simulation
Theater Logistics
(Within theater movement of units and supplies)
- Intended to replace SUMMITS simulation
Joint Warfighting
(Combat, maneuver, C3)
- Intended to replace TACWAR, CEM, Thunder, and ITEM simulations
Perception

Release 1 Warfare Functionality - Summary (slide 1 of 2)

Limited IOC Functionality	Release 1.3
C4ISR	
Communications	Implemented
Intelligence	
Sensing	
Reconnaissance	
Perceived Truth	
Indications & Warning	
JTF Command and Control	Functional; work continues
Collection Plan	
Land	
Maneuver	Implemented
Direct Fire	
Indirect Fire	
Forcible Entry (Airborne)	
Maneuver Planning	Functional; work continues
Attack Helos	
C2	
Resupply	In Development
Transportation and Logistics	
Intertheater Lift Scheduling	Implemented
Intertheater Lift Reschedule	
Intertheater Lift Movement	Functional; work continues
Intratheater Lift	
Intratheater Lift Reschedule	
Intratheater Transportation	
Installations	
Sustainment	In Development

Limited IOC Functionality	Release 1.3
Maritime	
Surface to Surface	Implemented
Sub on Ship	
Naval Blockade	
ASW (Sub on Sub)	
MW (Mine Deployment)	
NSFS	
Forcible Entry (Amphib)	
C2	Functional; work continues
ASW (Ship on Sub)	In Development
ASW (Air on Sub)	
Combatant Logistics Force	
WMD	
Chem Offense	Implemented
Chem Defense (MOPP)	
Unit Effects (Land)	Partially Implemented
Unit Effects (Air)	In Development
Unit Effects (Installations)	
Data Entry / Retrieval	
Import/Export to Oracle Database	Capable
Add/Modify Orders	
Data Modification	
Data Dictionary (On-Line View)	
Comparison of Scenario Data	
Export Data (Instruments)	

Limited IOC Functionality	Release 1.3
Air	
Operational C2	Implemented
CAS C2 & Execution	
Cruise Missiles	
Dyanamic ATO Planning	
Counter Air (A2A)	Functional; work continues
Attack / Interdiction (A2G)	
Air Defense (S2A)	
Air Base Ops	
JTCB Planning	
Air to Surface (ship)	In Development
SEAD	
TBM / TBMD	
Threat Missile	Implemented
ABL	
DSP Cueing	
BMC3	Functional; work continues
HE Effects	
Lower Tier (Patriot)	
Lower Tier (AEGIS))	
Upper Tier (THAAD)	
Upper Tier (AEGIS)	
Environmental Effects	
Terrain	Implemented
Networks (Land)	
Weather	Mostly Implemented
Ocenographics	

Notes: - Functional areas displayed are Release 1 (Limited IOC) requirements.

- By Release 1.4, all areas will be Implemented.

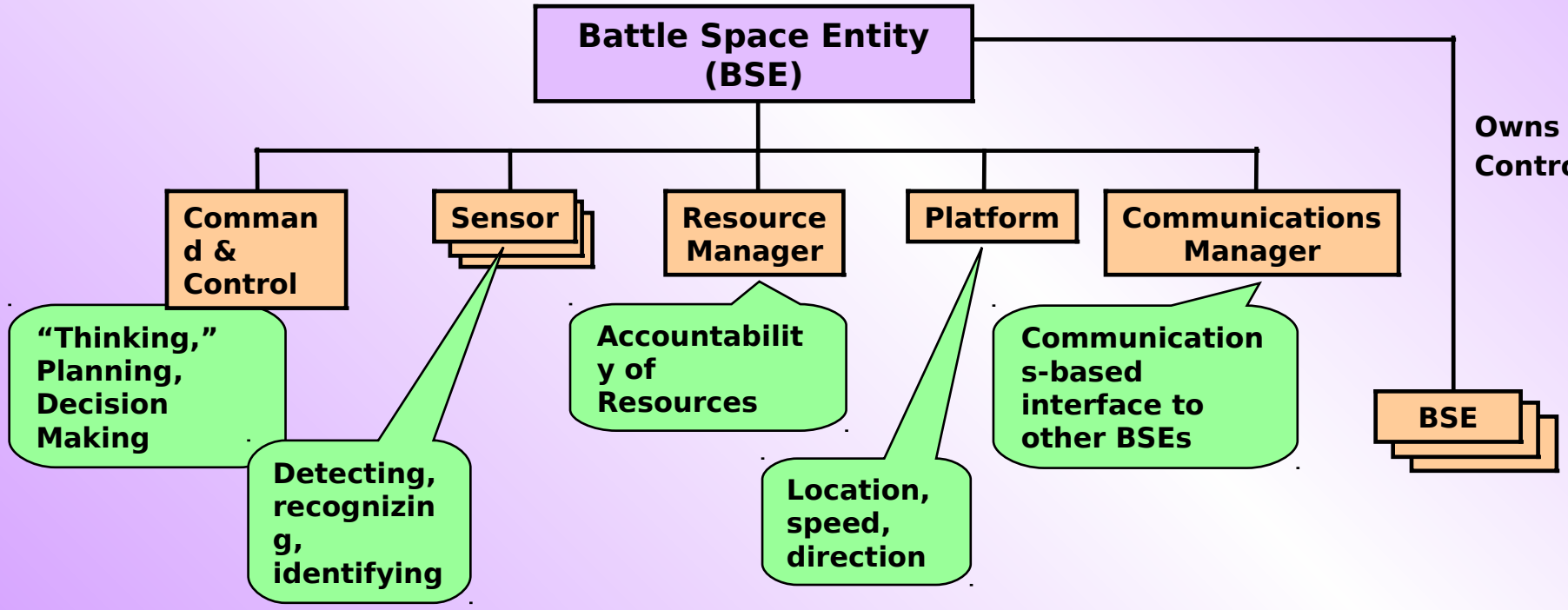
Agenda

- Background
- C4ISR Overview
- C2 Implementation
  - JTF
  - Air Component
  - Land Component
  - Maritime Component
  - Logistics
  - TBM
- Summary

Fundamental Warfare Functionality Component - Battlespace Entity (BSE)

- **BSE -- a friendly unit, enemy unit, or major system operating in the battle space. Examples:**
  - Operational Headquarters
  - Strategic aircraft and ships
  - Airbases and seaports
  - Land: Maneuver Battalion
  - Air: Air Mission Element
  - Space: Sensor Satellite
  - Maritime: Ship, Submarine

- **Represented as a "composite software object." Top-level decomposition:**



ISR System Representation

Air

Cobra Ball

F-14 TARPS

Global Hawk

JSTARS

Predator

Rivet Joint

Guardrail

U-2

P3/EP3

Space

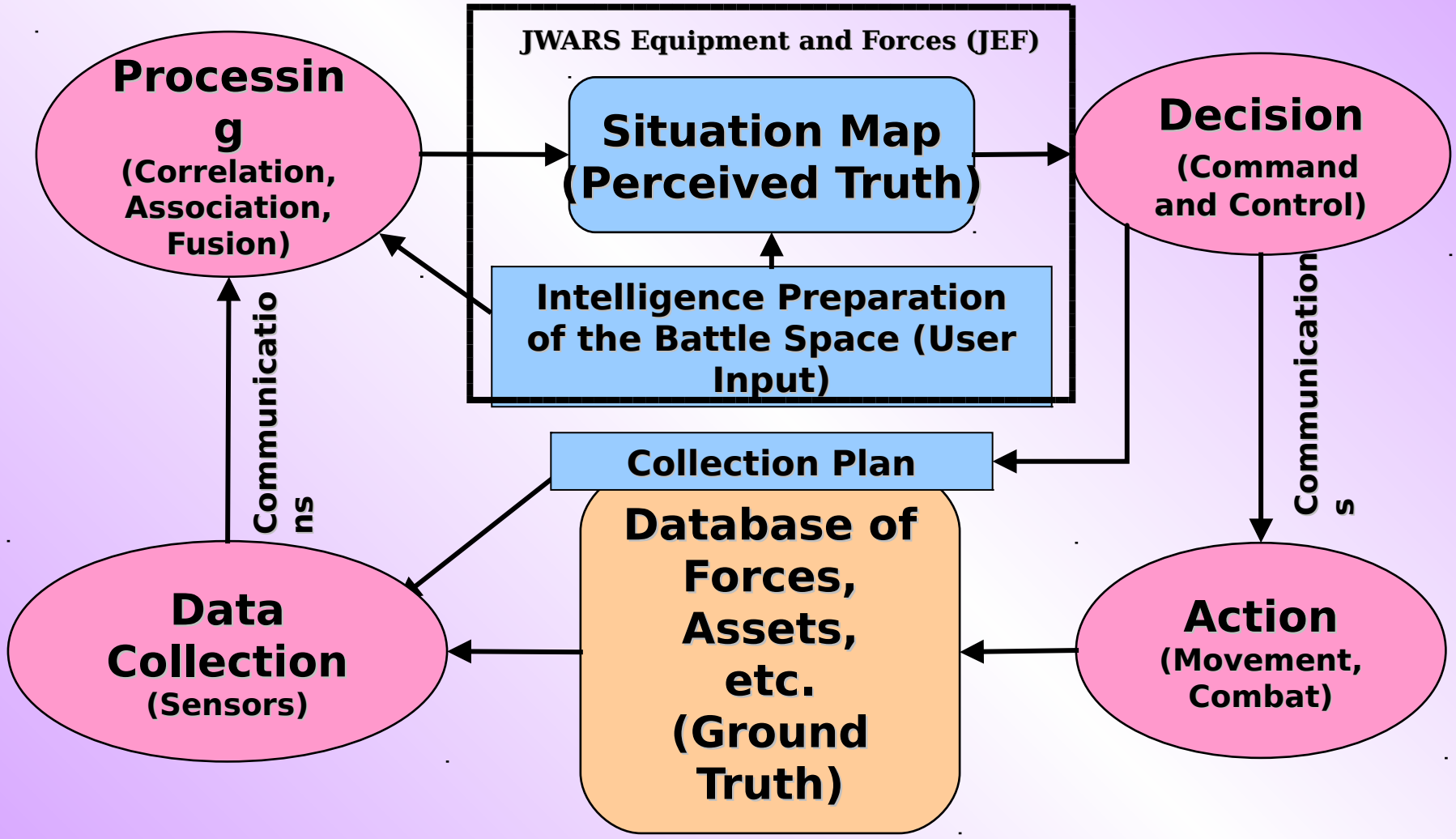
Surface/Subsurface

ISR Sensor categories represented in JWA

- Electro-Optical (EO)
- Infra Red (IR)
- Synthetic Aperture Radar (SAR)
- Moving Target Indicator (MTI)
- Communications Intelligence (COMINT)
- Electronic Intelligence (ELINT)
- Human Intelligence (HUMINT)
- Measurements &Signatures Intelligence (M

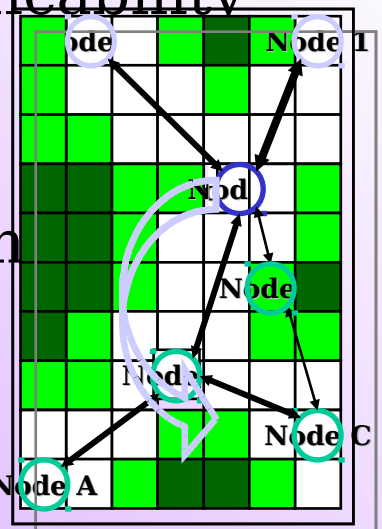
NOTE: In order to represent any possible future, JWARS provides a generic capability to represent any kind of platform and associate with it any kind of sensor with any intelligence discipline. The fact that such a modeling capability exists does not imply that any such system exists, is planned, or is even feasible.

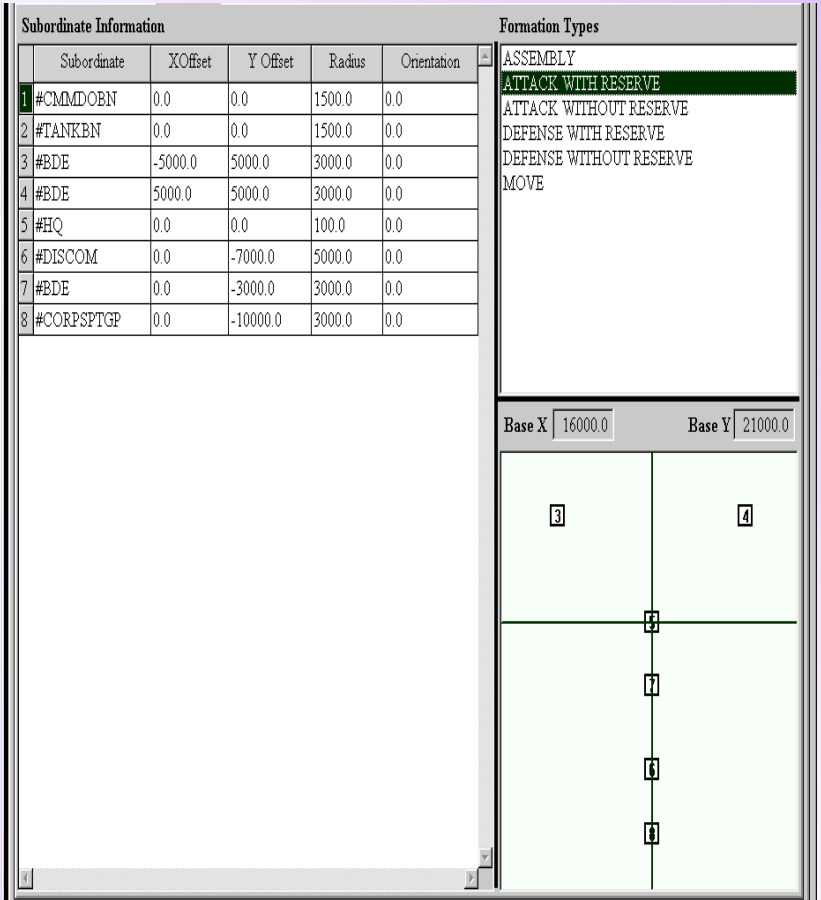
Logical Structure (C4ISR Based)



Intelligence Preparation of the Battlespace

- User specified at initialization
- Order of Battle information (examples)
  - Friendly/OPFOR (unit strength, garrison location, org type)
  - Doctrine (Templates)
- Environmental Informat
  - Terrain (Go/No Go)
  - Terrain Trafficability
  - Day / Night
  - Atmosphere
  - Oceanograph
- Etc.

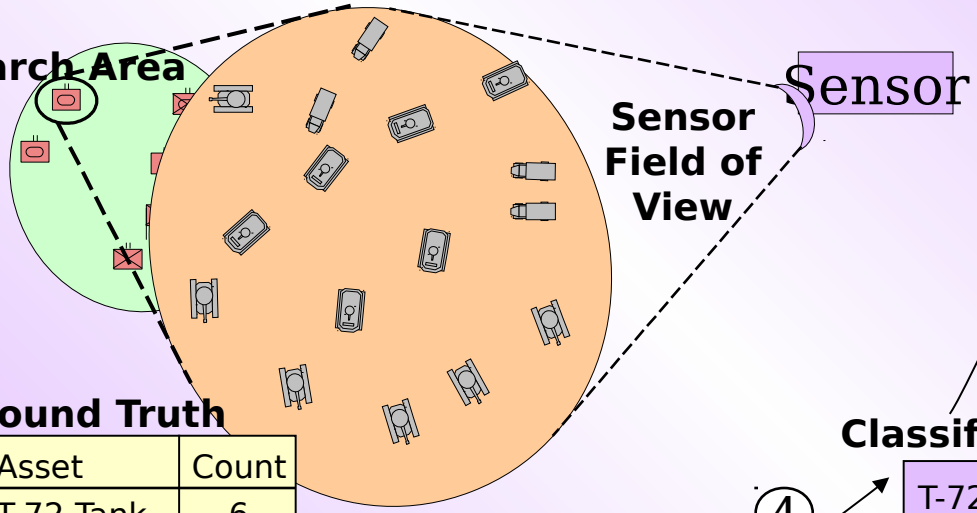




Collection Plan

- Intelligence requirements
  - Description
  - Search Location
  - Search Timing (if applicable)
  - Processing - Immediate or Periodic Fusion
  - Satisfaction Criteria - Absence, presence, strength, condition, activity, etc.
  - Priority
  - Intelligence Disciplines (leads to sensor allocation)
  - Quality (NIIRS equivalent)
  - Report Requirements (when, to whom)
- Platform / Sensor Tasking
  - Daily Air & Space mission tasking based on current situation
  - Alternate system(s) tasked if primary not available

Data Collection - Asset Counting



Resulting Sensor Repo

T-72 Tanks	1
Tank	4
IFV	3
Track Vehicle	1
Truck	3
Vehicle	1
Total	**13**

⑤ **Perceived**

Ground Truth

Asset	Count
T-72 Tank	6
BMP 2	6
Zil 90 Truck	4
Total	16

Classification Results

T-72	Tank	IFV	Track	Truck	Vehicle
1	3	0	1	0	0
0	1	3	0	0	1
0	0	0	0	3	0

④

①

③

Classification Matrix

Actual / Perceived	T-72	Tank	IFV	Track	Truck	Vehicle	Total
T-72 Tank	.20	.60	.10	.05	.03	.02	1.0
BMP 2	.02	.08	.84	.04	.02	.04	1.0
Zil 90 Truck	.00	.02	.03	.05	.85	.05	1.0

Detection Probabilities

T-72 Tank	0.8
BMP 2	0.7
Zil 90 Truck	0.5

②

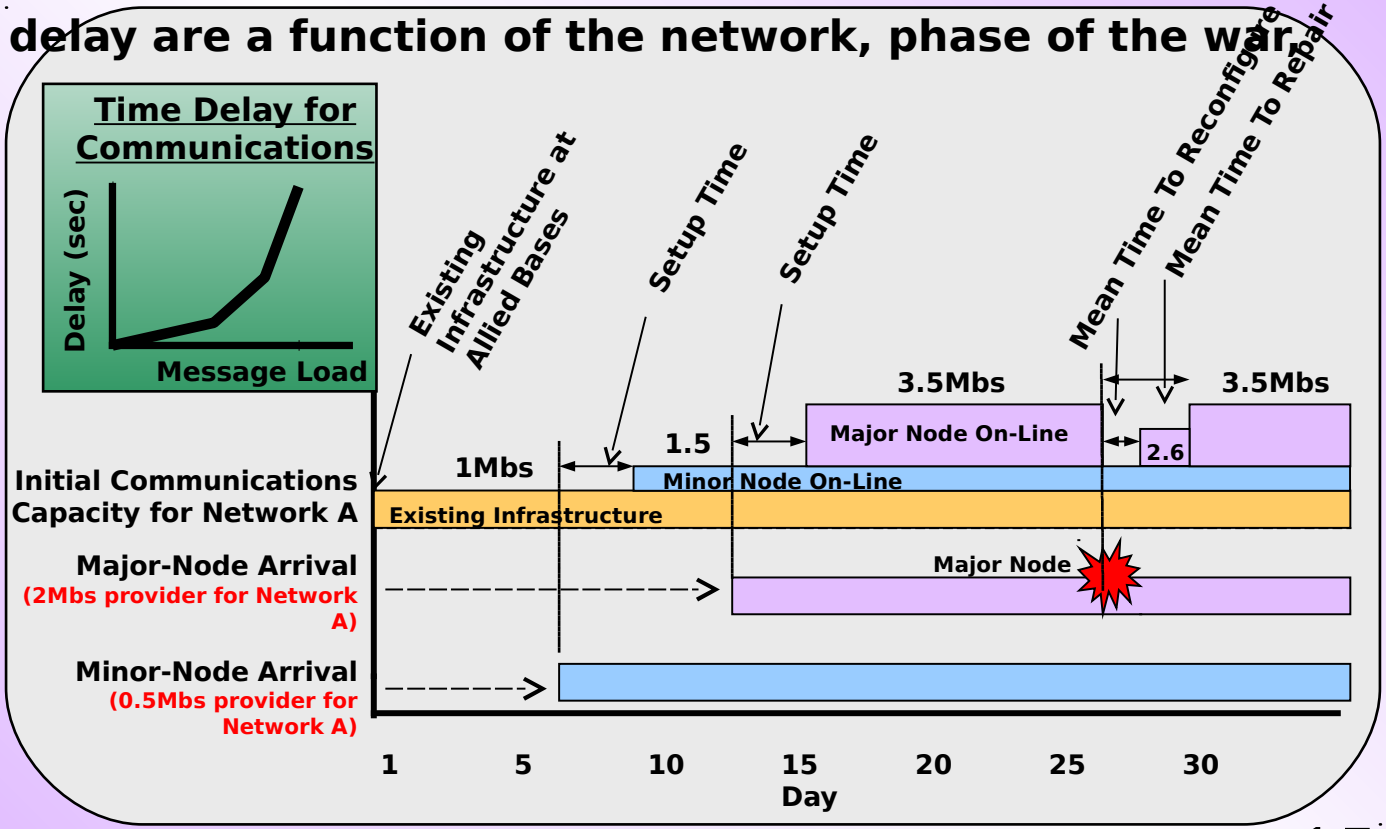
Detected

T-72 Tank	5
BMP 2	5
Zil 90 Truck	3

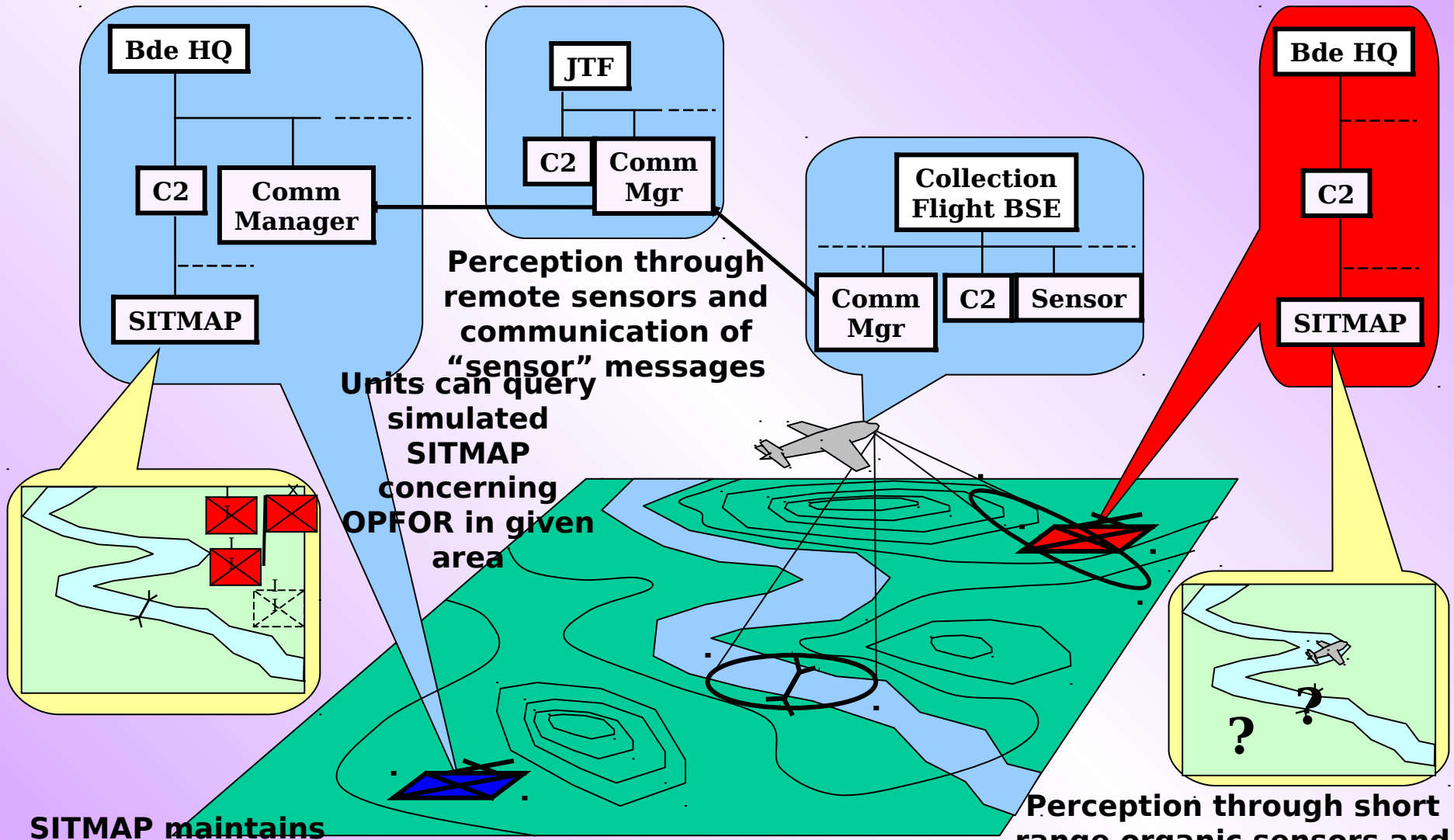
Probabilities of detection, classification and identification can be affected by target's activity, local visibility, countermeasures (future), and local terrain/vegetation (future)

Communications

- Important messages are simulated explicitly; others are “background” traffic.
- 144 message types sent explicitly, e.g.:
  - *Sensor Reports (multiple types)* - *Resupply Requests*
  - *Battle Damage Assessments* - *Undersea Warfare Orders*
- Multiple networks with individually defined capabilities.
- Network load and delay are a function of the network, phase of the war, and time of day.
- No constraint on # of networks, providers, and subscribers.
- Each unit can be on multiple networks.
- Network performance and connection defined in data, which can be modified by



Processing


Bde HQ
C2
Comm Manager
SITMAP
JTF
C2
Comm Mgr
Collection Flight BSE
Comm Mgr
C2
Sensor
Bde HQ
C2
SITMAP
Perception through remote sensors and communication of "sensor" messages
Units can query simulated SITMAP concerning OPFOR in given area
SITMAP maintains status of installations and feature (e.g.,
Perception through short range organic sensors and communication of "in contact" messages and MISREPs

Processing Components

- Correlation
  - Determine whether multiple sensor reports refer to a common entity
- Processing Time
  - Add Processing, Exploitation, and Dissemination (PED) delays
- Association
  - Match sensor report (or set of reports merged per correlation) with a particular perceived entity; if not, create a new perceived entity
- Fusion
  - Update perceived attributes of perceived entity based on all available information, present and past
- Purge
  - Delete mobile entities that are “too old.”
- Assess the Situation
  - Generate new collection requirements
    - Satisfy Information Requests and reduce average age of targets

Situation Map

- Referred to as the JEF (JWARS Equipment & Forces) or as the COP (Common Operational Picture)
- Maintained at the JTF-level
- Accessible by any BSE
- Information Variability
  - Timeliness
    - PED Delay, Age of Information
  - Accuracy
    - Unit Identification (multiple classification levels)
    - Strength Estimate - Mean & Variance
    - Geo-Spatial - Location & Velocity (subject to collection error)
  - Subject to Negative Information
  - Can be deceived

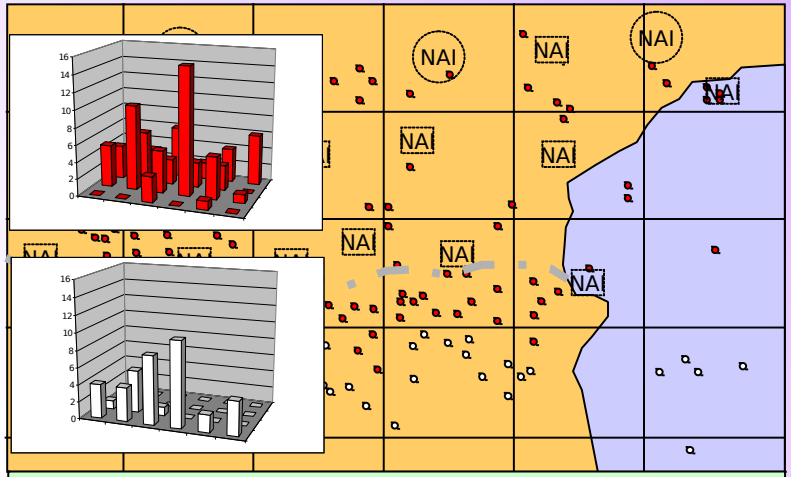
Decisions and Actions
(Based on Perception)

Indication & Warning

Blue JTF Phase 1 (Deter/Deploy)

STATE	STATE NAME	Major Enemy Movement Perceived	Major Enemy Movement Perceived Below Designated Phase Line	JTF Actions
S1	#PREAMBIGUOUS	False	False	No action Rqd
S2	#AMBIGUOUS	True	False	I-Day Declared
S3	#UNAMBIGUOUS	True	True	W-Day Declared C-Day Declared at W+24 Hrs
S4	#SURPRISED	False	True	I-Day and W-Day Declared C-Day Declared

Maneuver Planning



- **Maneuver and Fire Support decisions are based on relative density of friendly & enemy forces**
  - ***Opposing force information derived from perception***
  - ***Own force information***

Targeting

Joint Target Coordination Board (JTCB) assess available targets and

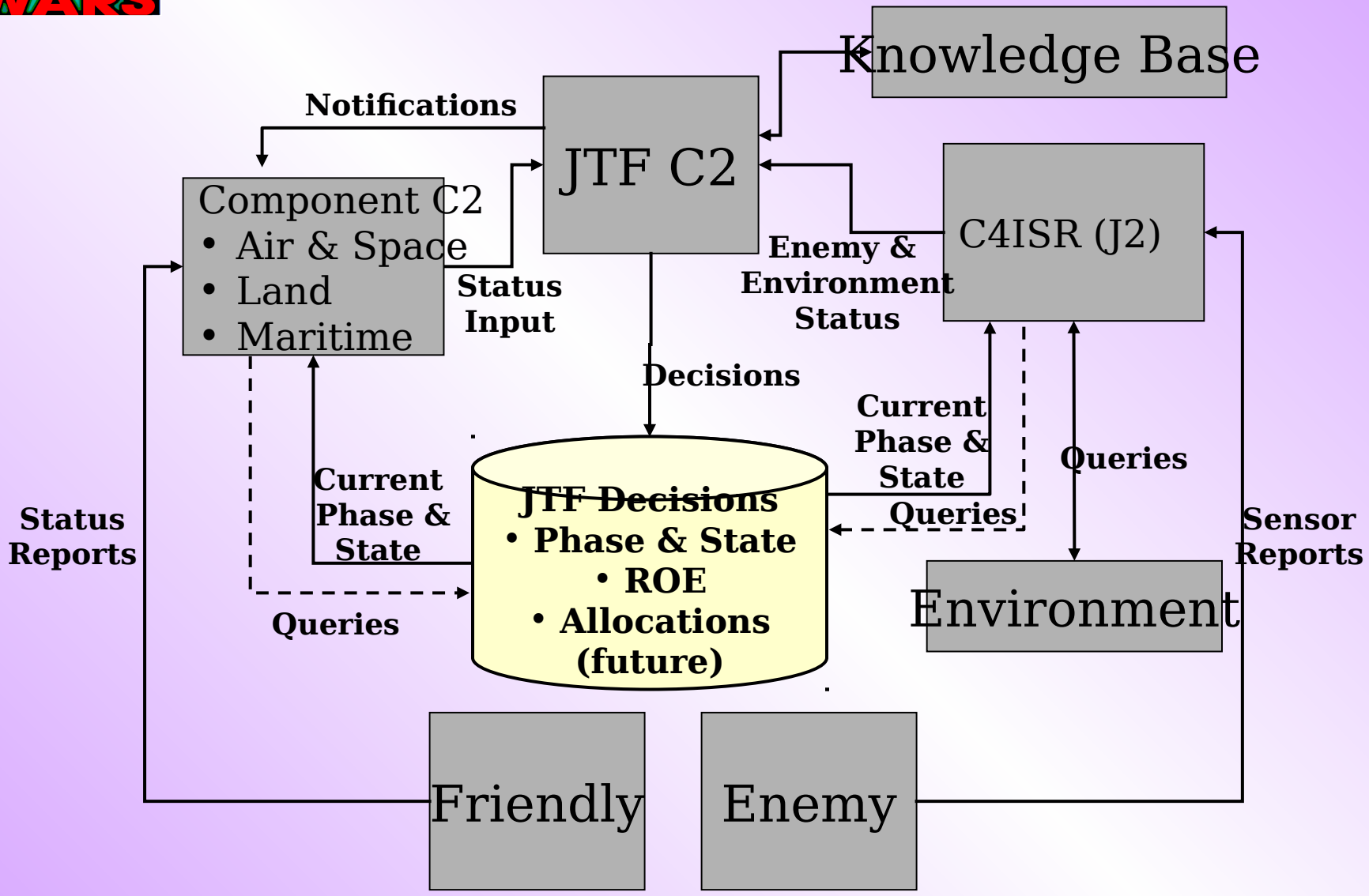
Agenda

- Background
- C4ISR Overview
- C2 Implementation
  - JTF
  - Air Component
  - Land Component
  - Maritime Component
  - Logistics
  - TBM
- Summary

JTF Command & Control Considerations

- Operational Structure
  - Command and Control Hierarchy
  - Orders
- Awareness - situation relative to mission accomplishment
  - Information from its own organic sensors
  - Information through communications with other BSEs
  - Query the JWARS Equipment and Forces (JEF)
- Commanders
  - Decisions - based on available information not ground truth
    - For Land Forces, an optional commander bias can be added

JTF C2



JTF C2 processes depend on explicit communica

JTF C2 Decisions

- User specifies overall campaign objectives
- JTF C2 decisions made dynamically
  - Indications and Warning
  - Declaration of Phase & State
  - Joint Targeting
  - Planning
  - Battle Damage Assessment (BDA)
- Satisfies information needs in areas such as
  - Air Superiority achieved/not achieved
  - SLOC Open/Closed
  - Ground Forces in Contact with the OPFOR
  - Ground Units Off-Plan

JTF C2 Decision Events (Criteria)

- Phase and State Rules
- Rules of Engagement (ROE)
- Enemy situation
- Perceived Changes in control of the Arc-Node Network
- General planning guidance
- Changes in the environment (future)
- Changes in political boundaries / coalition membership* (future)
- Delay in execution of operational plans (e.g., amphibious assault with multi-Service support)

JTF Collection Plan

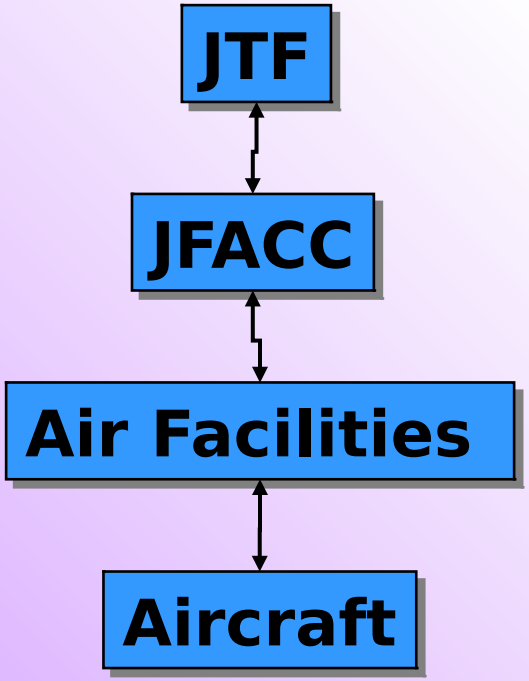
- Intelligence gathering based on operational situation assessment (changes reflected in the Collection Plan)
  - Change collection priority
  - Reprioritize platform / sensor collection
  - Change area collected against
  - Execute Component Commander requests for information
    - ISR support to the amphibious assault
    - ISR support of SEAD
    - ISR support of joint targeting, pre-strike target confirmation and post-strike BDA

JTF Collection Plan Prioritization

- Search priorities are set by the JWARS user for:
  - Each phase (e.g., pre-hostilities, defense, and counter-offense)
  - Assignment of a search area by platform / sensor pair
    - NAI, UAI, Cued, MSN, and JEF
  - Multiple area deconfliction
- Uses revisit time, priority, and last time searched to allocate Satellite-EO each period

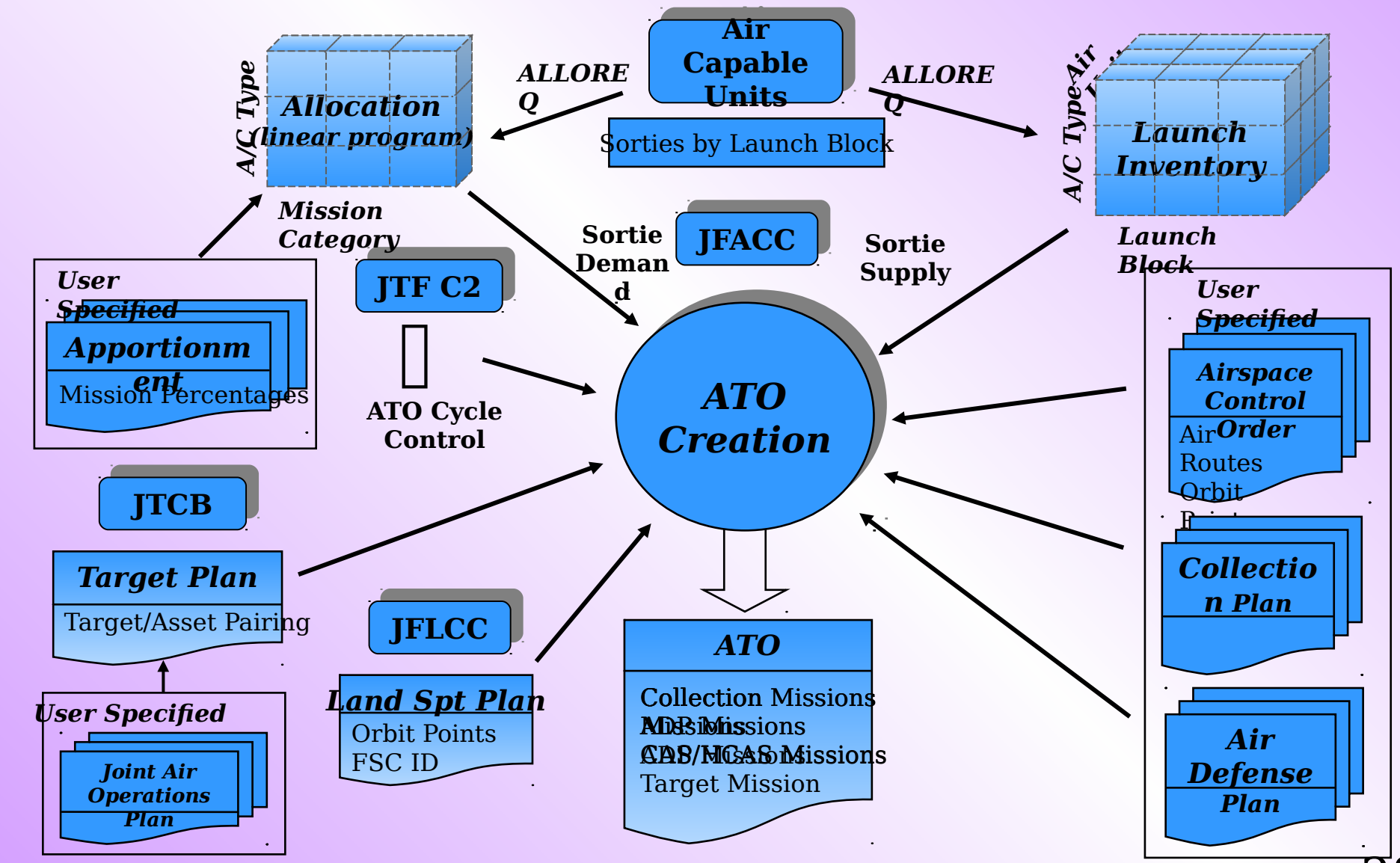
Air Component C2

- Structure



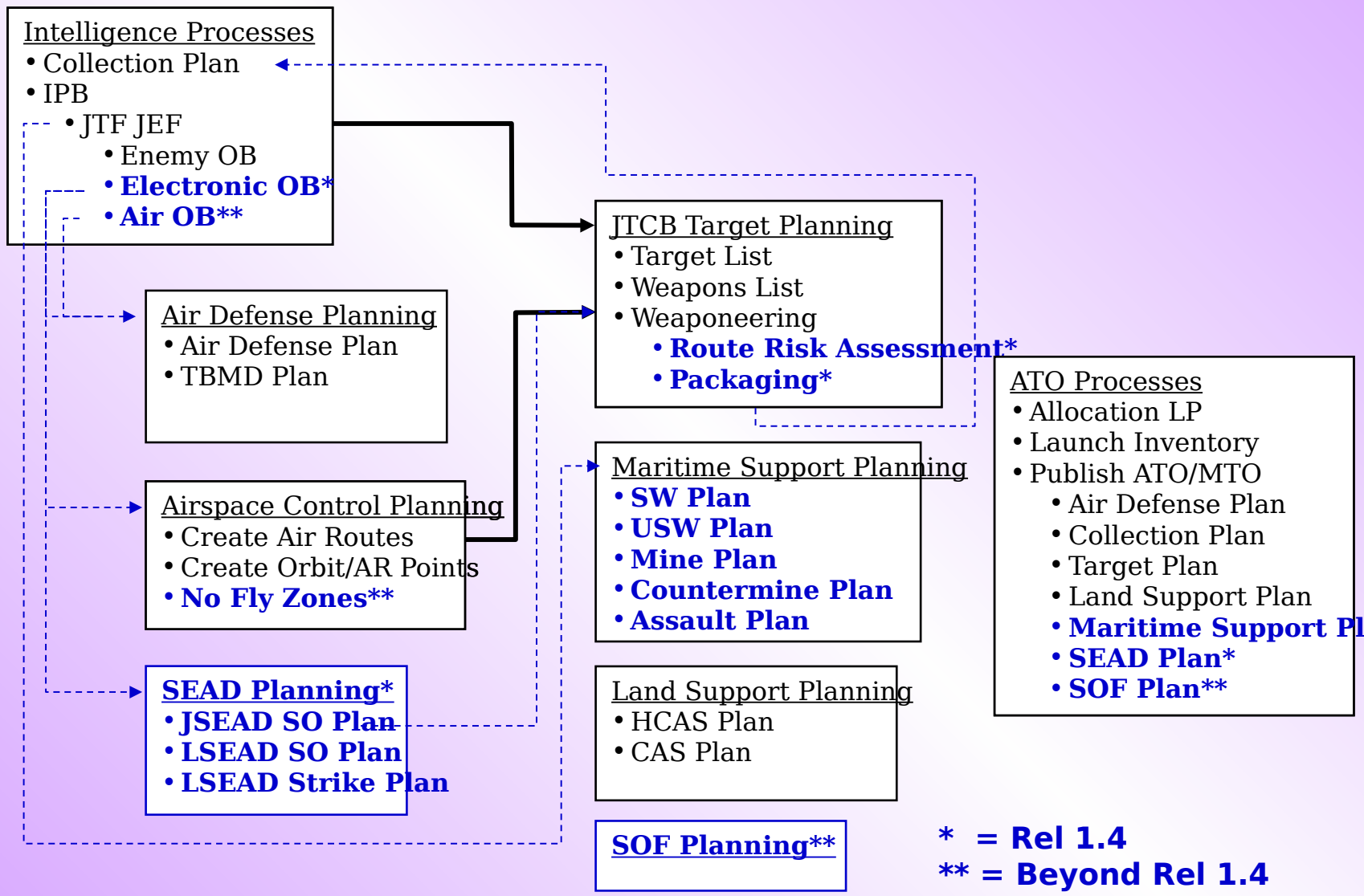
- Awareness
  - JTF Phase & State
  - JEF (via queries)
    - Target Location
    - BDA
  - Sortie availability
  - Targeting priorities
  - Component Commanders Plan
    - JFLCC CAS & Attack Helos
    - JFMCC
  - Other Plans
    - JTF Collection Plan
    - Air Defense

Air Warfare Planning



Integrated Air Planning

(High Level View)



* = Rel 1.4

** = Beyond Rel 1.4

Air Missions

(1 of 2)

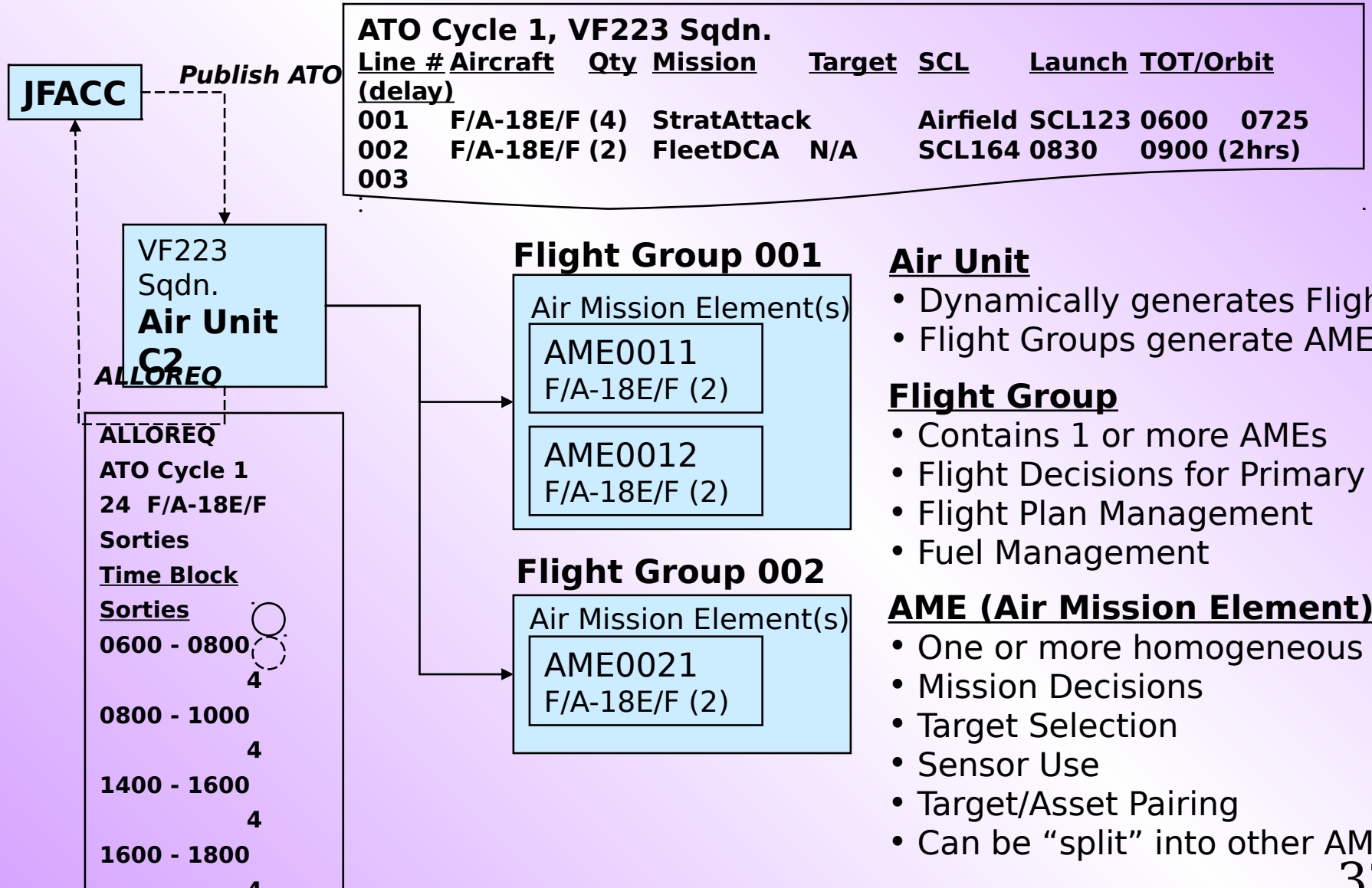
Joint Mission Terms Types	JWARS Air Missions	AME C2
• Counterair	- Defensive Counterair (DCA)	- CAPC2
	- Fleet DCA	- CAPC2
	- Air-to-Air Weapons Control	- AEWC2
	- Offensive Counterair Strike	- StrikeC2
	- Boost Phase Intercept (BPI)	- ABLC2
• Close Air Support (CAS)		- CAS - CASC2
	- CAS Weapons Control	- CASWCUC2
	- HCAS	- HCASC2
	- HCAS Weapons Control	- HCASWCUC2
• Air Interdiction	- Preplanned Strike	- StrikeC2
	- Jamming SEAD Standoff	- JSEAD-SOC2
	- Jamming SEAD Escort	- JSEAD-EC2
	- Lethal SEAD Standoff (ARMs)	- LSEAD-SOC2
	- Lethal SEAD Escort (ARMs)	- LSEAD-EC2
	- Lethal SEAD Strike (non-ARMs)	- SEADStrikeC2

Air Missions

(2 of 2)

Joint Mission Terms Types	JWARS Air Missions	AME C2
• Sea Control	- Surface Warfare Surveillance	- SWSurvC2
	- Surface Warfare Strike	- SWC2
	- Surface Warfare Wpns Control	- SWWCC2
	- Undersea Warfare Surveillance	- UWSurvC2
	- Undersea Warfare Strike	- UWC2
	- Undersea Warfare Wpns Control	- UWWCC2
	- Mine Laying	- LMineC2
• Strategic Attack	- StratAttack	- StrikeC2
• Other	- ISR (Collection Operations)	- IntelC2

Flight Group Creation Example



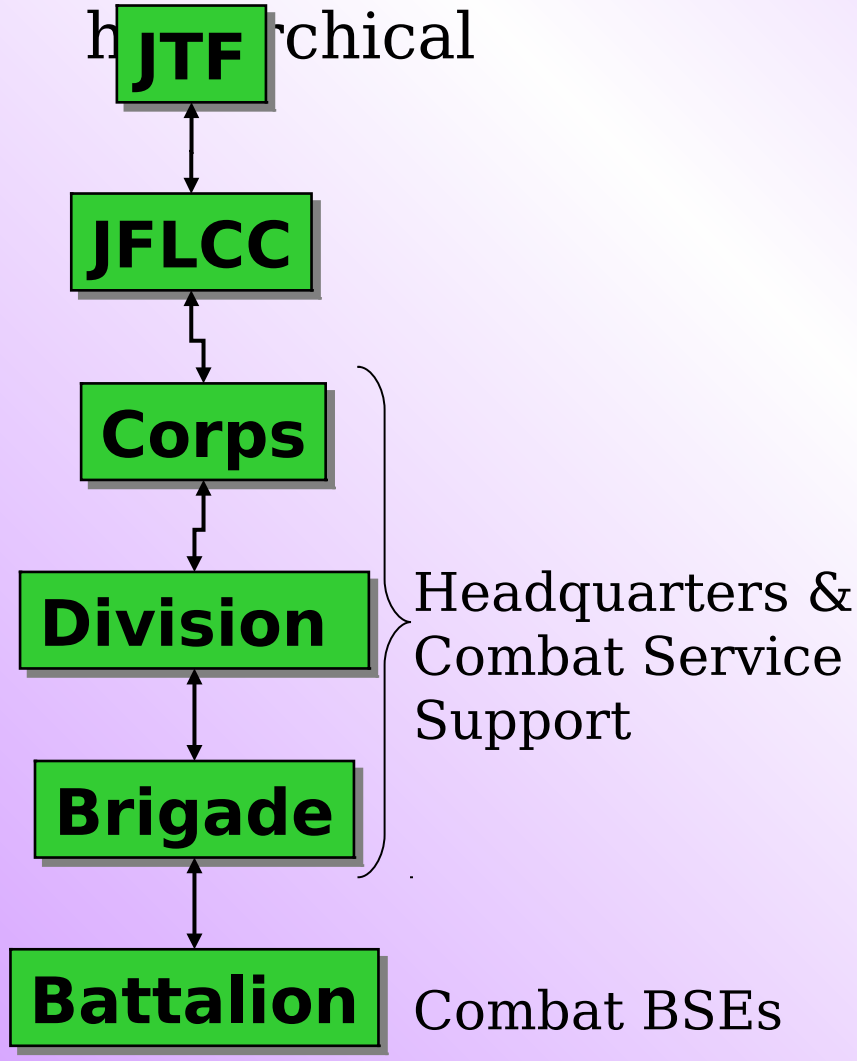
Air Unit
- Dynamically generates Flight G
- Flight Groups generate AMEs

Flight Group
- Contains 1 or more AMEs
- Flight Decisions for Primary AM
- Flight Plan Management
- Fuel Management

AME (Air Mission Element)
- One or more homogeneous A/C
- Mission Decisions
- Target Selection
- Sensor Use
- Target/Asset Pairing
- Can be “split” into other AMEs

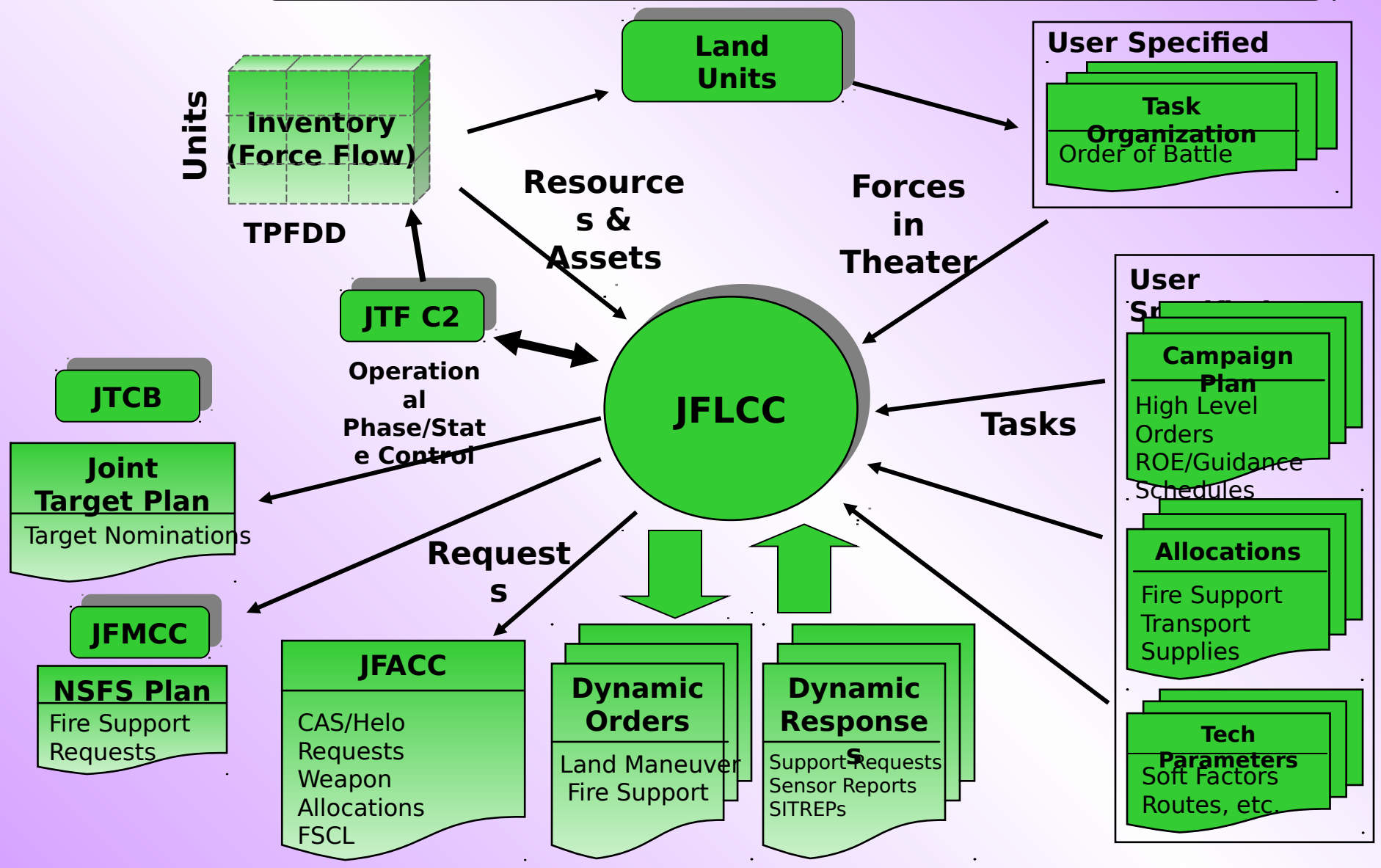
Land Component C2

- Structure - Very hierarchical

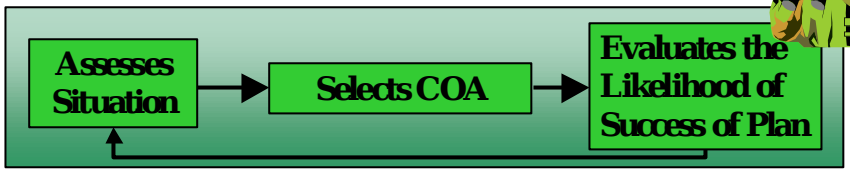


- Awareness
  - JTF Phase
  - JTF Guidance
  - JTF Rules of Engagement (ROE)
  - Orders from superior units
  - JEF updates via queries
  - Own local sensors
  - SITREPs and sensor reports from subordinate units
- Maneuver Planning
  - Employ IPB from JEF
  - Get estimates of enemy strength in assigned area of responsibility

Land Warfare CONOPS Implementation



Land Commander



Considers METT-T:
- Friendly mission
- Enemy capability
- Friendly capability
- Environment
- Schedule

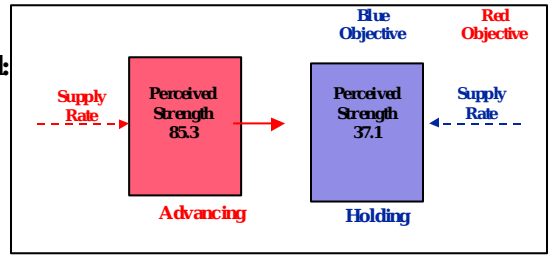
Ensures COA:
- Accomplishes mission
- Meets schedule
- Provides best value
- Offers acceptable risk

Periodically:
- Checks thresholds
- Evaluates "off plan"
- Decides if time to replan

The Land Commander performs a Commander's Wargame of the likely Courses of Action (a simulation of the simulation)

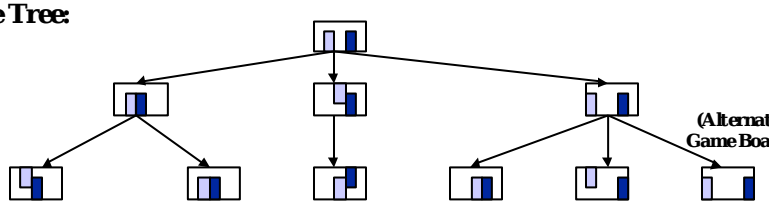
CM Plays "chess" with a Game Tree made of Outcomes of Game Boards

A Game Board:



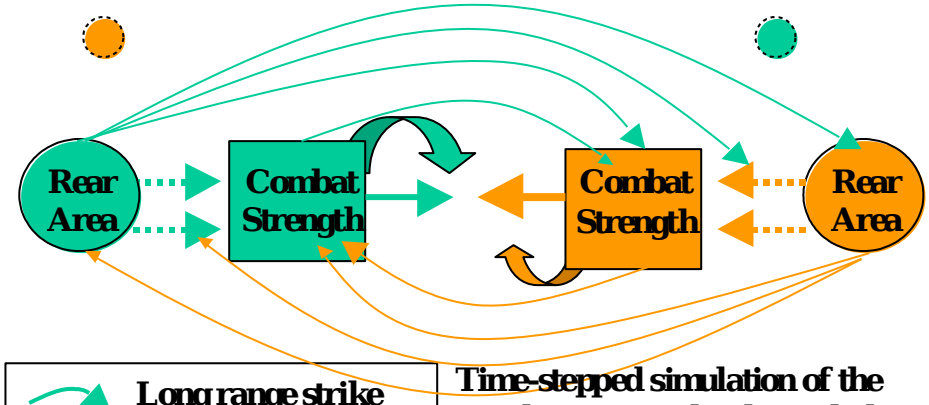
(Simulation of the Land Simulation)

A Game Tree:



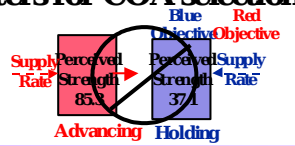
(Alternative Game Boards)

The Improved Game Board

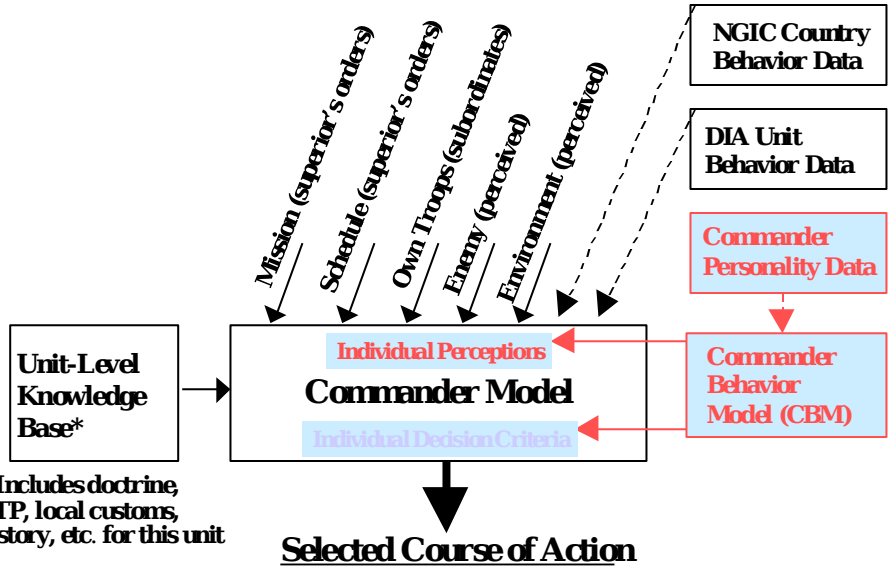


- Long range strike
- Reserves & supplies
- Force movement
- Force maneuver
- Force Intel capability

Time-stepped simulation of the simulation provides the underlying parameters for COA selection



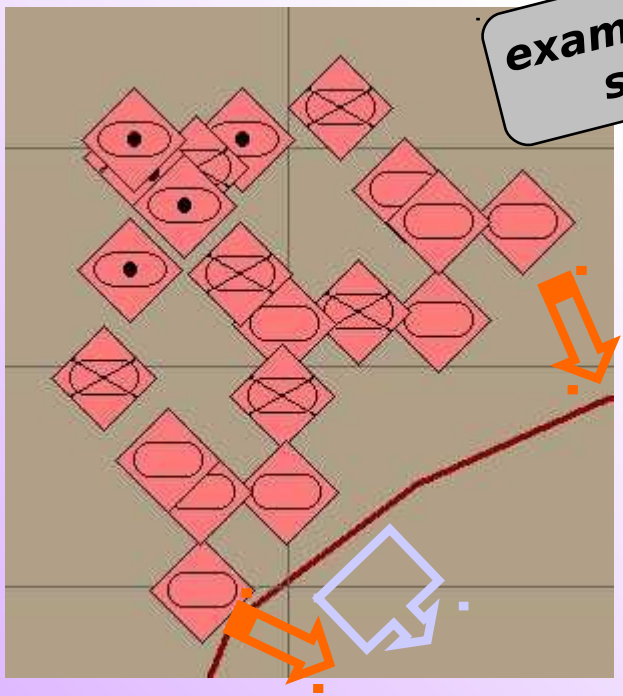
JWARS C2 Design with CBM



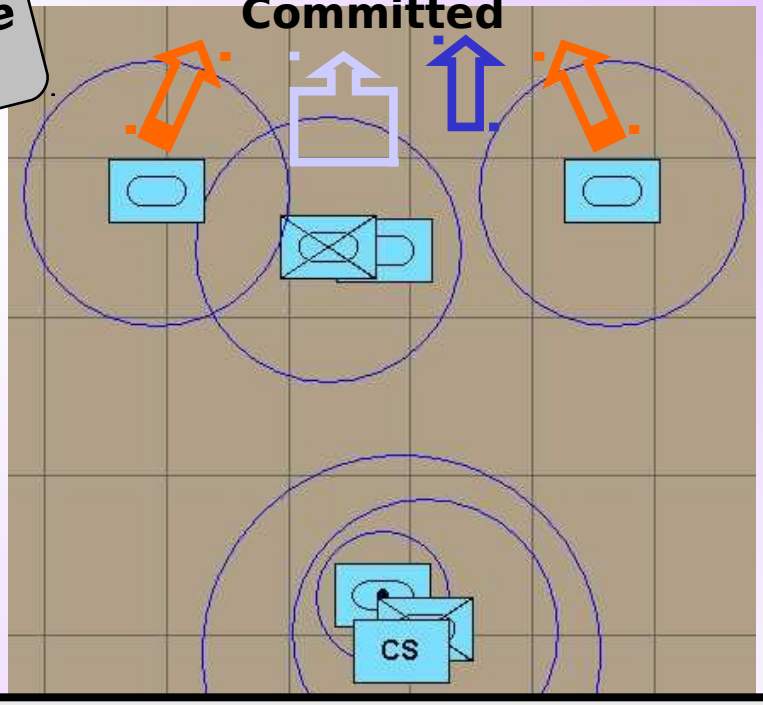
* Includes doctrine, TTP, local customs, history, etc. for this unit

Land Combat Operations

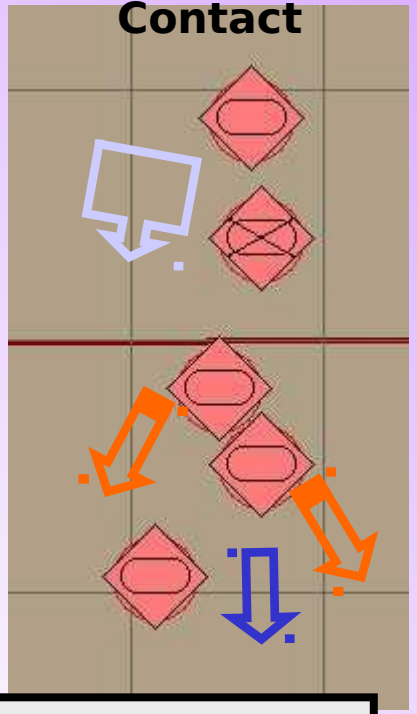
Defend with Reserve



No Reserve or Reserve Committed



Advance to Contact



LEGEND

Unit Movement Vecto

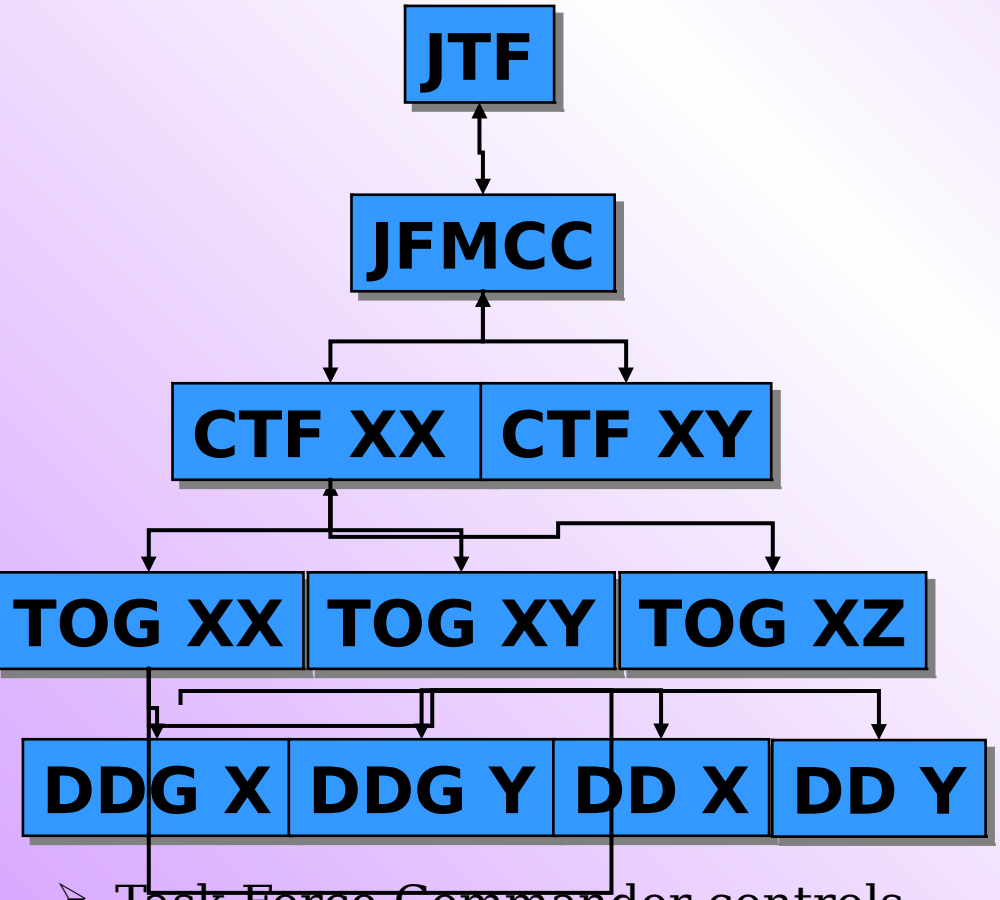
Weapon Orientation

Unit Formation Orientation

- ***Attack activity seeks combat, but not on any terms (unless so ordered).***
- ***Plans are simplistic, but will be more maneuver oriented under the Maneuver Planner.***
- ***Boundaries will constrain units, and unit formations will automatically adjust to***

Maritime Component C2

- Structure - Dynamic

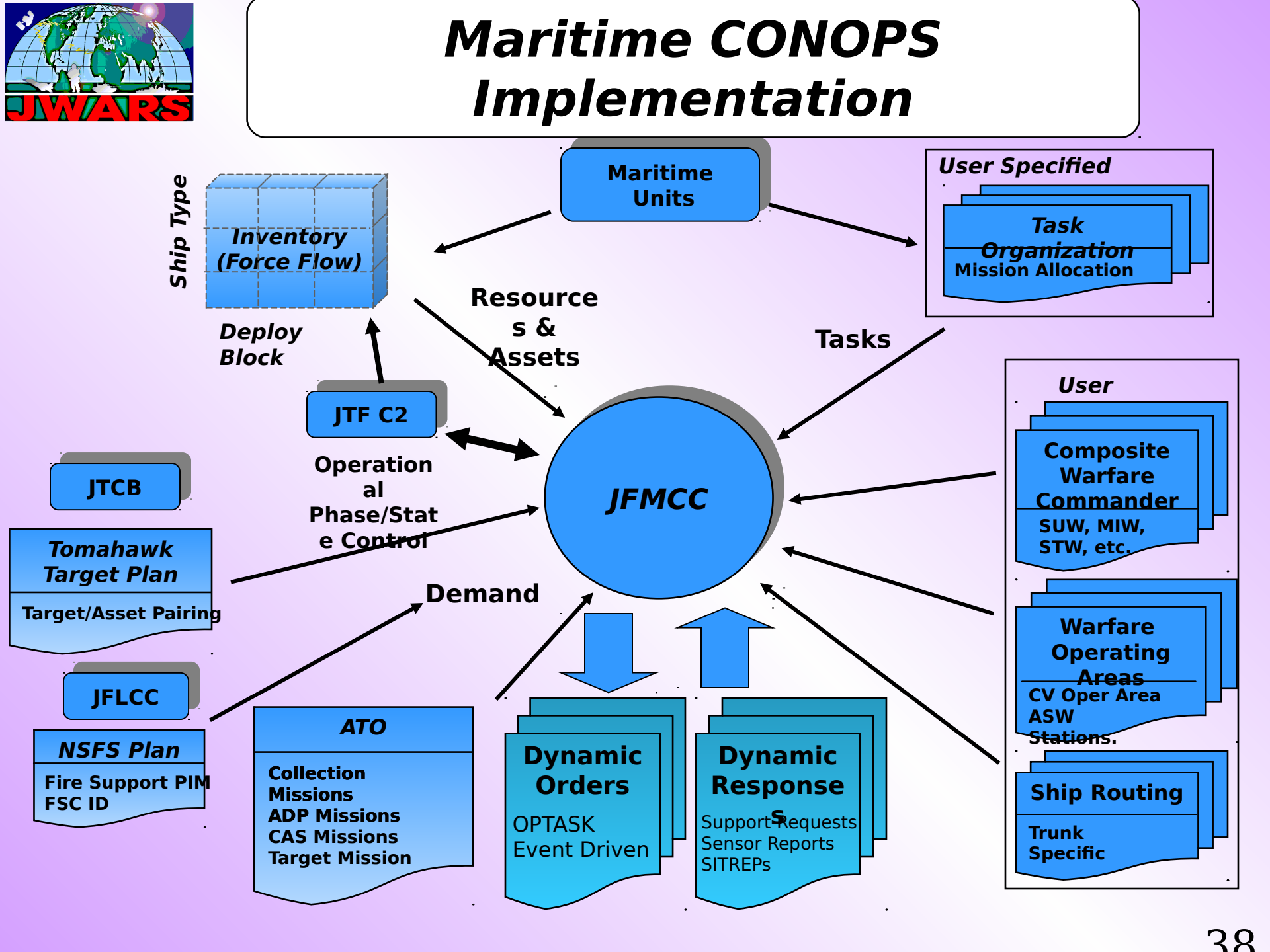


- Task Force Commander controls one or more TOGs. A TOG controls one or more

- Awareness
  - » JTF Phase & State declarations
  - » JEF via queries
  - » Own tactical sensor(s)
  - » From superior/subordinate units
  - » Mission orders and status
    - ◇ Pending, In Process, Canceled, On Hold, Complete

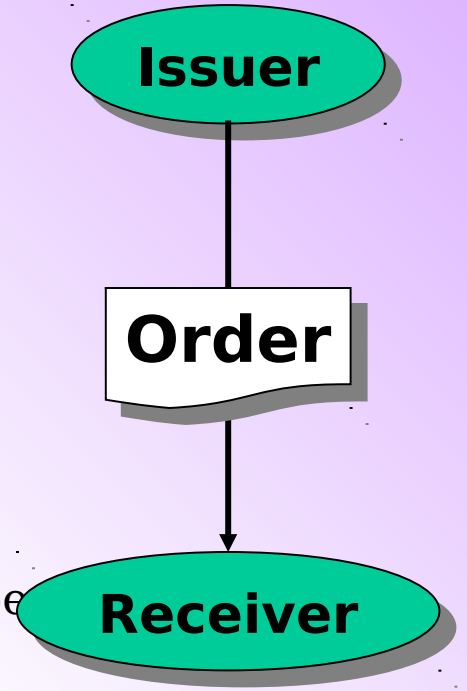
* TOG - Task Oriented Group

Maritime CONOPS Implementation



Maritime Order

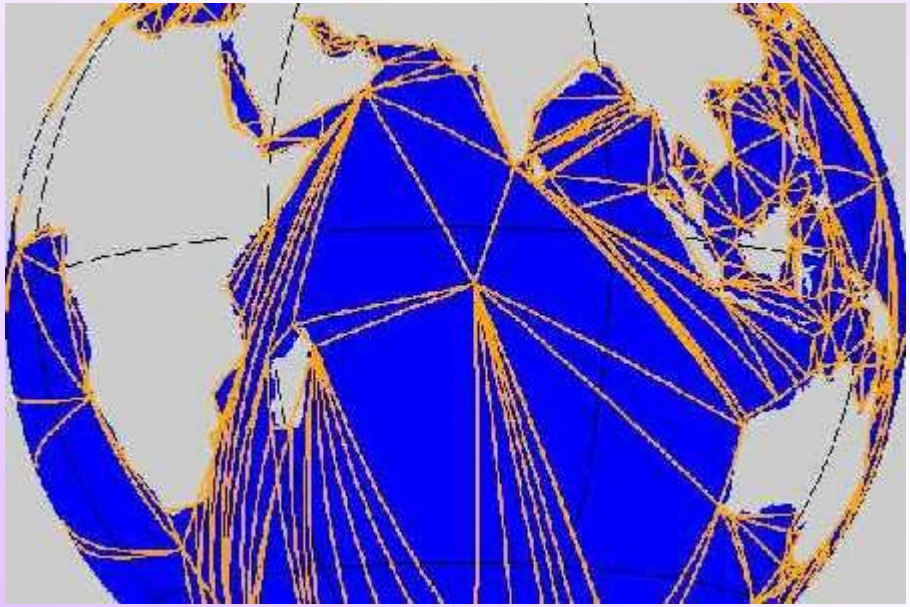
- Specific action to take { What not How }
- An order is issued
  - By Issuer (may be itself)
    - Sets Priority
    - Issues all guidance needed for that order
      - times
      - locations
    - Tracks Order
    - Cancels order
  - To Receiver
    - Determines how to accomplish the order
      - Course of Action selected on constraints and pe
    - Tells issuer when an order is
      - Accomplished
      - Off schedule



Origin of Maritime Orders

- From Superior or Self as part of a CONOP
- From scripted order
  - Input at Theater level, but only applicable to designated units
- From self in response to events
    - Task are invoked with a given priority on an “as needed” basis
    - Units returns to previous task when this one completed (if it is still applicable)
    - When entering the theater { INCHOP orders }

Strategic Logistics C2



Structure: JTF Transcom

Awareness: Installation Status, Prohibited Airspace, Asset Availability

- Deployment Mode Selection

  -Assign ULNs to carriers

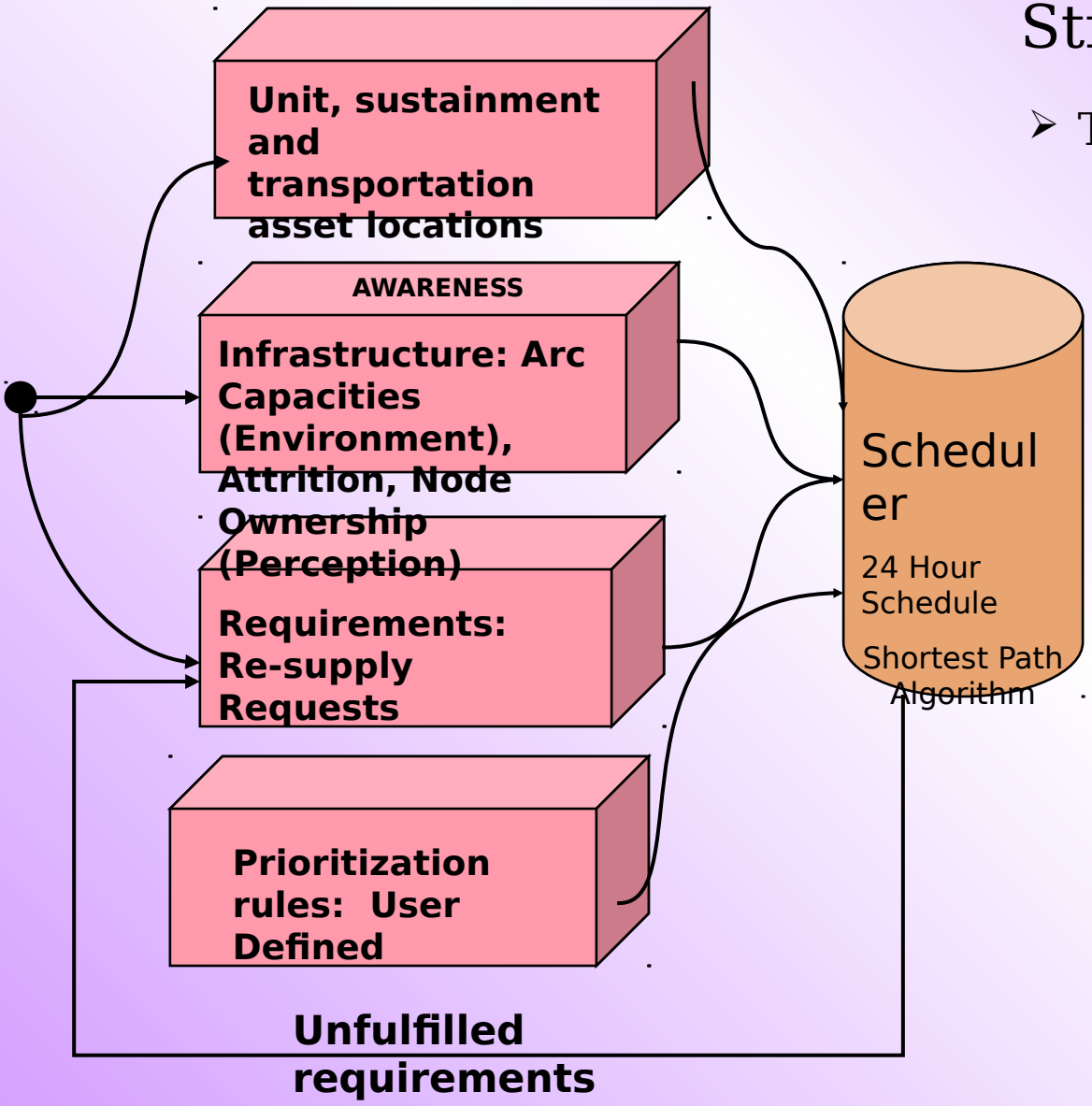
- Air Route Selection
- Sea Route Selection

  -Assign Carriers to Routes

- Airlift Scheduling
- Sealift Scheduling

  -Schedule Carrier Loading,
  -Departure and Arrival

Intra-Theater Logistics C2

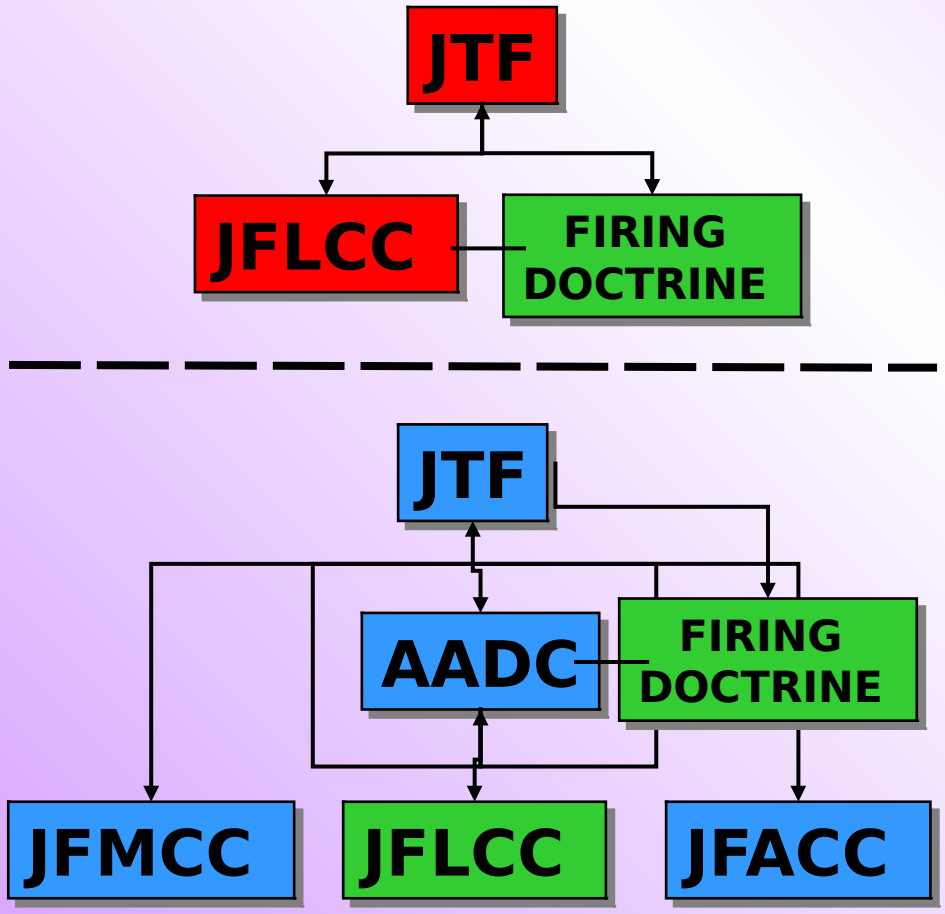


Structure: JTF → J4

- Theater
  - » Unit Equipment Moves From PODs
    - ◇ From strategic lift operations
  - » Resupply Moves from PODs to Depots or to ships (CLF)
    - ◇ From strategic lift operations
  - » Unit Moves Within Theater (BSEs)
    - ◇ Administrative relocation
  - » Resupply Moves from Depots to BSEs over road/rail networks
    - ◇ Delivery of sustaining supply

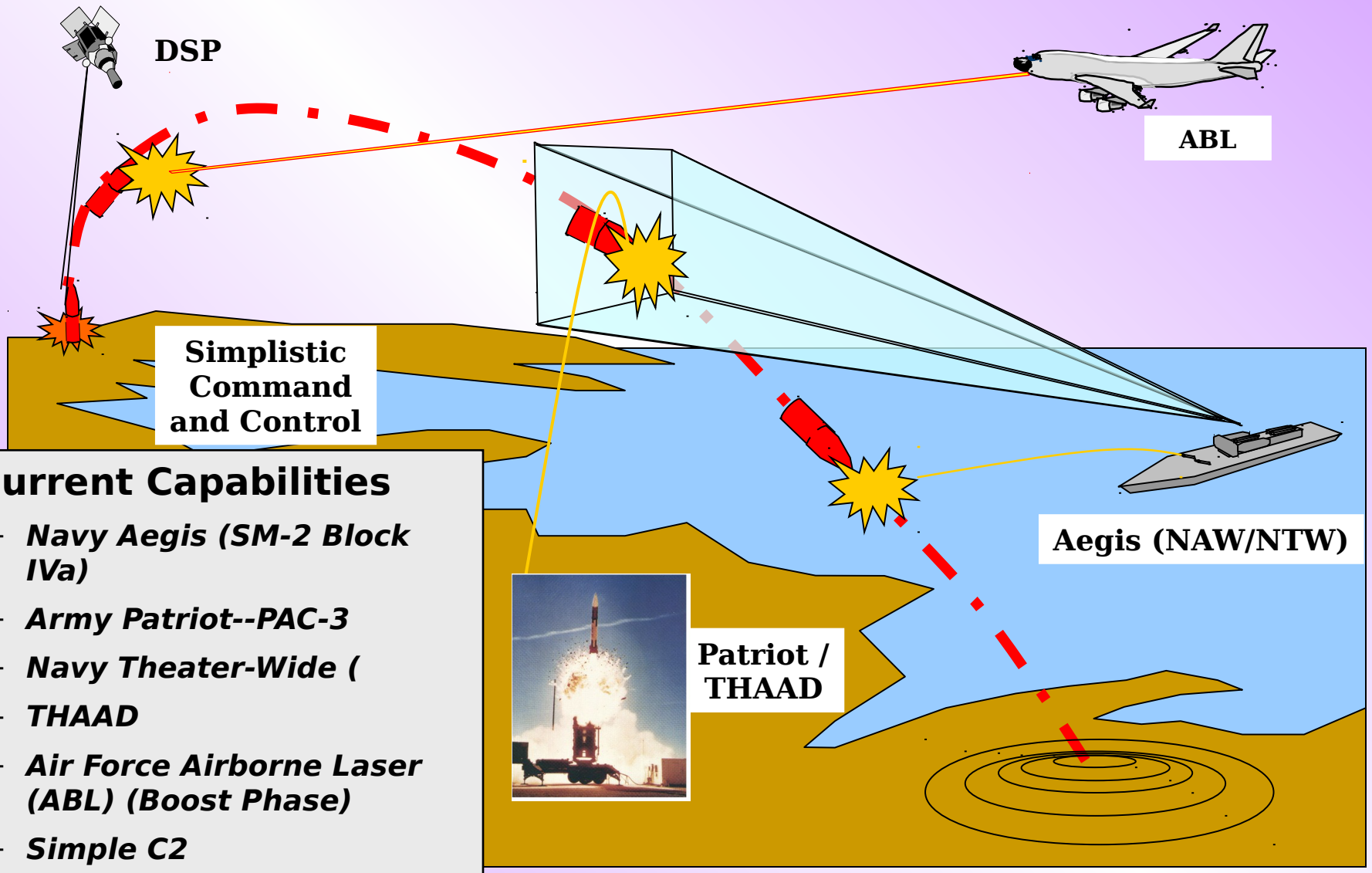
TBM/TBMD C2

- Structure



- Red Functionality
  - » Scripted Move Orders
  - » Scripted Launch Orders
  - » User Input Firing Doctrine
- Awareness - Blue Functionality
  - » Launch Detections
  - » Sensors through the comm system
  - » Asset availability/status
  - » Dynamic Firing Doctrine

TBM/TBMD C2



- **Current Capabilities**
  - *Navy Aegis (SM-2 Block IVa)*
  - *Army Patriot--PAC-3*
  - *Navy Theater-Wide (*
  - *THAAD*
  - *Air Force Airborne Laser (ABL) (Boost Phase)*
  - *Simple C2*
- **Future Enhancements**

Agenda

- Background
- C4ISR Overview
- C2 Implementation
  - JTF
  - Air Component
  - Land Component
  - Maritime Component
  - Logistics
  - TBM
- Summary

C2 Decision Algorithms Summary

- JTF
  - Boolean Rule Set
- Air
  - Command Hierarchy - JFACC, AME
  - Linear Program - ATO planning for aircraft/weapon allocation
  - Boolean Rules- CAS, SEAD, and Air-to-air weapons control SEAD planning
- Land
  - Command Hierarchy - JFLCC, Armies, …, BN
  - Commander's Wargame - Course of Action assessment
    - Fuzzy Rule Sets and Game Theory
- Maritime
  - Command Hierarchy - JFMCC, Task Forces, …, Ship
  - Boolean Rule Sets - Course of Action assessment
    - Moving towards CBM & Fuzzy Rule Sets used by Land

C2 Decision Algorithms Summary

- Amphibious Operations
  - Boolean Rule Sets - Go/No Go decisions
- Transportation & Logistics
  - Routing & scheduling - Strategic and Theater lift
  - Shortest path - Ground movement network
- TBMD
  - Boolean Rule Sets - weapon system tasking
- Collection Planning
  - Greedy Algorithm for IR prioritization
- Joint Targeting
  - Greedy Algorithm for target weaponeering

Questions?